(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 344 780**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89109945.9

(51) Int. Cl.⁴: F02D 9/02 , F02M 3/08

(22) Date of filing: 01.06.89

(30) Priority: 03.06.88 JP 135610/88

(43) Date of publication of application:
06.12.89 Bulletin 89/49

(84) Designated Contracting States:
FR IT

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(54) Intake control device for engine.

(57) An intake control device for an internal combustion engine comprises, in an intake passage downstream of a throttle valve, a secondary valve (6). Said secondary valve is bypassed by a low speed air passage (7) of small cross-section. Within said low speed air passage, an intake opening-closing valve (9) is provided which is to be closed while the intake valve (3) of the internal combustion engine is open. The intake opening-closing valve (9) is controlled via an engine crankshaft.

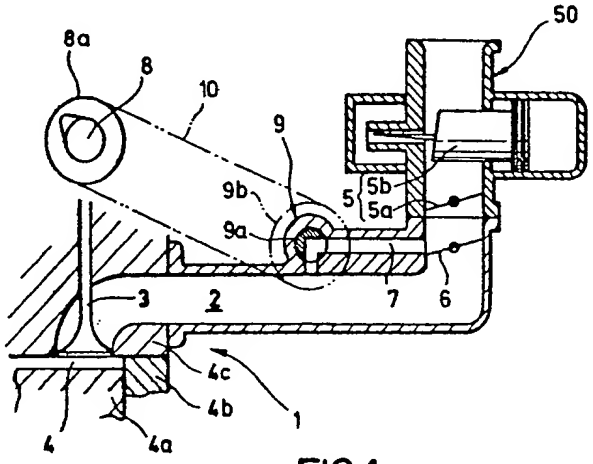

FIG.1

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INTAKE CONTROL DEVICE FOR ENGINE

The present invention relates to an intake control device for an internal combustion engine, particularly to an intake control device for reducing the power loss caused by a pumping action of the engine.

One of the factors which reduces the thermal efficiency of an engine is the so-called pump loss. A major cause of the pump loss is the intake airflow resistance through a narrowed intake passage around a throttle valve at the time of a low engine load operation when the opening of the throttle valve is small.

A known example for reducing the pump loss is the so-called Miller-cycle engine (disclosed for example in the Japanese publication No 58-40260 (utility model), No 60-536 (patent), No 60-65230 (patent) etc) wherein a rotary valve provided on the downstream side of a throttle valve in an intake passage substantially closes said intake passage while an intake valve is open.

The known engines enumerated above, however, had the disadvantage that the rotary valve of a large size for closing and opening the intake passage was interposed in the intake passage and not only excessively increased the airflow resistance and lowered a high load performance but also required a large amount of power to rotate the rotary valve and impeded the increase in the output at the time of low load operation.

The object of the present invention is to provide an intake control device which eliminates the disadvantage described above by reducing the pump loss as well as by reducing the large amount of power required for rotating the large-sized rotary valve, thereby improving the thermal efficiency of the engine. According to the present invention, the above object is achieved by the intake control device as defined in claim 1.

When an engine runs under low load conditions, the secondary valve is closed and all the intake air is introduced through the low speed air passage to the combustion chamber. The low speed air passage is provided with the intake opening-closing valve for closing an intake opening-closing section during the downward stroke of a piston in a similar manner to that of the conventional Miller-cycle engine so that only the air present on the downstream side of said section is taken in. Shortly after the piston turns to the upward stroke, the intake valve is closed and approximately at the same time the intake opening-closing valve is opened to introduce the atmosphere to the downstream side of the intake opening-closing valve. When the engine load increases, the second valve is opened such that the major portion of the intake air will bypass the intake opening-closing valve to reach the combustion chamber through an intake passage of a larger cross-section.

An embodiment of the present invention is hereinunder described according to the description of the drawings in which:

Fig 1 is a schematic sideview in section of the intake control device according to the present invention attached to a cylinder head section of an engine; and

Fig 2 is a timing diagram of the intake valve and the intake opening-closing valve.

One end of an intake passage 2 of a four-cycle internal combustion engine 1 is connected to a combustion chamber 4 via an intake valve 3 while the other end thereof is connected to the atmosphere. A carburettor 50 of known type is interposed in said intake passage 2 and provided with an artificially controlled butterfly type throttle valve 5a and with an automatic valve 5b of a piston type to be closed when the engine runs with a low load. A piston 4a forming one wall of the combustion chamber 4 fits freely slidably to a cylinder 4b, and is covered with a cylinder head 4c from above.

A secondary valve 6 of a butterfly type to be opened when the engine load is high is provided in the portion of the intake passage 2 downstream of the throttle valve 5. Said intake passage 2 is provided with a low speed air passage 7 of a small cross-section bypassing said secondary valve 6. The low speed air passage 7 is provided with an intake opening-closing valve 9 driven in linked motion with a crankshaft (not shown in the drawing) via a cam shaft 8 for driving the intake valve and an exhaust valve.

Namely, the intake opening-closing valve 9 is of a rotary shape and driven via a timing chain 10 or the like routed between a driven sprocket 9b attached to a valve body 9a of said valve 9 and a drive sprocket 8a attached to the cam shaft 8. Here, the opening and closing timings of the intake opening-closing valve 9 is set as shown in Fig 2 to be opened while said intake valve 3 is closed and to be closed while the intake valve is open. Further, considering the influence of the flow resistance of the intake airflow in the cylinder and the inertia of said flow, it is preferable to correct the opening and closing timings to some extent based on experiments rather than strictly linking the opening and closing timings to each other. Further in Fig 2, while the opening period of the intake opening-closing valve 9 in the case of a single-cylinder engine as in the present embodiment can be longer as shown with dash-and-double-dotted lines, it is

necessary in the case of a multi-cylinder engine to make said period shorter as shown with solid lines.

Since the engine of the present embodiment is constituted as described above, the secondary valve 6 is closed when the engine runs under low load conditions and all the intake air is introduced through the low speed air passage 7 to the combustion chamber 4. The intake opening-closing valve 9 provided in the low speed air passage 7 is closed in a similar manner to that of the conventional Miller-cycle engine during the downward stroke of the piston 4a so that only the air present on the downstream side of said valve 9 is taken in. When the piston 4a turns to the upward stroke and the intake valve is closed, the intake opening-closing valve 9 opens approximately simultaneously to introduce the atmosphere to the downstream side of the valve 9. When the engine load increases, the secondary valve 6 is opened and most of the intake air bypasses the valve 9 and reaches the combustion chamber through the intake passage 2 of a larger cross-sectional area.

Although in the present embodiment a carborettor 50 is used, use is not limited to a carborettor but may of course be applied to an engine wherein a fuel injection pump is employed.

The inventive device is equipped as described heretofore with different intake passages respectively for low load and high load with the low load side intake passage being provided with the intake passage opening-closing valve to be opened and closed in linked motion with the crankshaft, more particularly to be closed while the intake valve is open. As a result, the intake air is supplied at the time of low load operation where the pump loss is great through the low speed air passage 7 provided with the intake opening-closing valve 9 thereby reducing the pump loss in a similar manner to that of the so-called Miller-cycle engine. At the time of a high load opration on the other hand, since the secondary valve 6 is open and most of the intake air reaches the combustion chamber 4 through the intake passage of a large cross-sectional area, the increase in the airflow resistance is small. In addition to the reduction in the pump loss, a large amount of power loss due to the power required to operate a large-sized rotary valve is reduced thereby obtaining an engine of an excellent thermal efficiency.

Claims

An intake control device for an engine comprising: a throttle valve (5) provided in an intake passage (2) connecting a combustion chamber (4) to the atmosphere via an intake valve (3); a secondary valve (6) provided on the downstream side of said throttle valve (5) in said intake passage (2) and to be opened when the engine load is high; a low speed air passage (7) of a small cross-section bypassing said secondary valve (6); and an intake opening-closing valve (9) provided in said low speed air passage (7) and to be opened and closed, more particularly to be closed while the intake valve (3) is open, in linked motion with a crankshaft (8).

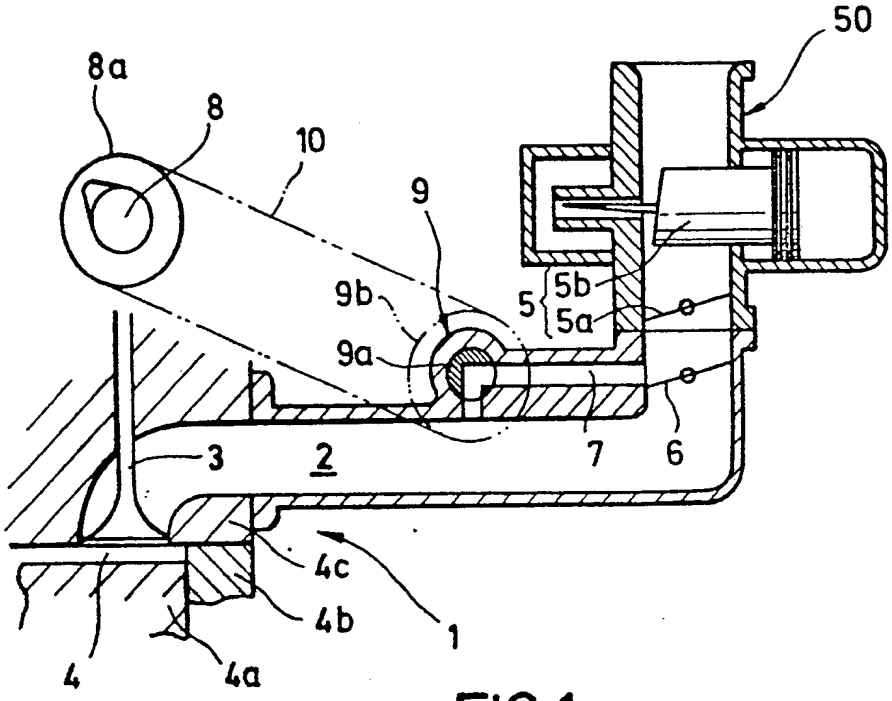
50
8a
8
10
9
9b
9a
5
5b
5a
3
2
7
6
4c
4b
1
4
4a

FIG.1

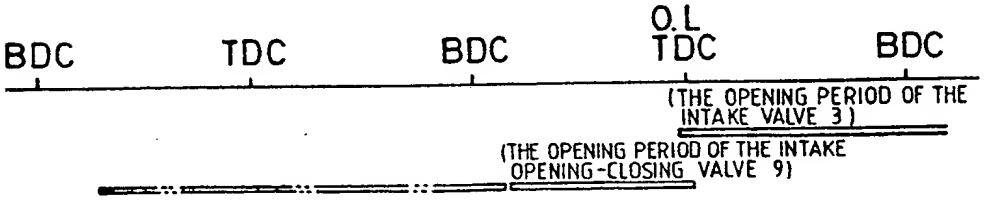
BDC
TDC
BDC
O.L
TDC
BDC
(THE OPENING PERIOD OF THE INTAKE VALVE 3)
(THE OPENING PERIOD OF THE INTAKE OPENING-CLOSING VALVE 9)

FIG.2